REMARKS

Claims 38-46 were examined and rejected on formal and substantive grounds. Claims 38-46 have been amended. Claims 17-37 and 47 have been canceled without prejudice pursuant to a Restriction Requirement. Applicants reserve the right to pursue patent protection for these inventions in a subsequently filed application. Claims 48-63 have been added. Re-examination and reconsideration of pending claims 38-46 and 48-63 are respectfully requested.

Amendment To Specification/Drawings

Applicants have amended the specification to add description of subject matter already disclosed in Figure 8, as originally filed on May 31, 1996. Figure 8 has been revised to include the specific reference numerals referred to in the amended specification. These amendments are supported in the original disclosure and are made for reasons of conforming one part of the application to another. As such, no new matter has been added. [See M.P.E.P. § 2163.07.]

Rejection of Claims under 35 U.S.C. § 112

Claims 38-46 were rejected under 35 U.S.C. § 112, second paragraph, as allegedly being indefinite. Applicants have amended claims 38-46 to recite the term "article" as suggested by the Examiner. As the amended claim language is now clear, Applicants respectfully request that the rejection under 35 U.S.C. § 112, second paragraph, be removed.

Rejection of Claims under 35 U.S.C. § 102

Claims 38, 39, and 41-46 were rejected under 35 U.S.C. § 102(e) as allegedly being anticipated by U.S. Patent No. 5,705,272, issued to Taniguchi. Claims 38, 45, and 46 were rejected under 35 U.S.C. § 102(e) as allegedly being anticipated by U.S. Patent No. 5,852,303, issued to Cuomo et al. Such rejections are traversed in part and overcome in part as follows.

To more clearly claim the present invention, Applicants have amended claim 38 to recite an article comprising a substrate and a layer disposed over the substrate. Specifically, the article of claim 38 now recites that the layer comprises a highly tetrahedral amorphous carbon having more than about 15% sp^3 carbon-carbon bonds and a single peak Raman spectrum, the layer further comprising at least one of hydrogen and nitrogen. Support for this amendment can be found throughout the originally filed application, and particularly with reference to Figure 8 and associated text on page 34, paragraph 4. Such a material characteristic is not shown or reasonably suggested in the cited art.

The Taniguchi patent describes a heating member having a lubricating and protective layer on a surface thereof. In particular, the vapor deposited layer may comprise an amorphous carbon layer or a diamond like carbon layer made from a mixture of diamond and graphite. [See col. 3, lines 33-40.] While the Taniguchi reference does mention that sp^3 bonds in the range from 40% to 70% may be present, a closer examination of this reference reveals that the physical bonding structures of such layers as characterized by a Raman spectrum indicates the presence of at least two strong peaks in the Raman spectrum. Specifically, Figure 3 in the Taniguchi patent illustrates a Raman spectrum for the layers in which there are strong peaks observed at 1550 cm^{-1} and 1360 cm^{-1}, indicative of graphite G and D lines, along with a third diamond peak at 1333 cm^{-1}. [See col. 4, lines 33-43; Figure 3.] Hence, the presence of a significant D peak in the Raman spectrum clearly shows that there are significant amounts of graphite, i.e. sp^2 carbon-carbon bonds, present in the layers disclosed by Taniguchi.

In contrast, the present invention claims a highly tetrahedral amorphous carbon having a single peak in the Raman spectrum. As shown in Figure 8 of the present application, the claimed highly tetrahedral amorphous carbon having more than about 15% sp^3 carbon-carbon bonds exhibits a single peak in the Raman spectrum, centered approximately at 1518 cm^{-1}. As explained by Z.J. Zhang, et al., in "*The Effect of Sputtering Ions on the Structure and Properties of Diamond-Like Carbon Films*," J. of Phys.: Condens. Matter, **11** (1999) pp. L273-L277 [copy enclosed as Exhibit A], it is known that the Raman spectra of diamond-like carbon films of high sp^3 content are well fitted by a single peak. Hence, a tetrahedral amorphous carbon layer having a single peak in the Raman spectra will also have high diamond sp^3 carbon-carbon bonding with little or no measurable graphite sp^2 carbon-carbon bonding (D peak Raman spectrum), unlike the layer described in the Taniguchi reference.

Applicants see no teaching or reasonable suggestion in the Taniguchi reference for the structural element of a single peak as claimed in claim 38. Applicants further believe that the claimed tetrahedral amorphous carbon having a single peak could not reasonably be produced by Taniguchi as the film depositions processes described in Taniguchi lack high ionic energy impact ranges, ionic filtering, and producing a stream of ions having a uniform weight and uniform impact energy. As explained in the present application on page 6, lines 8-38, these deposition characteristics can help promote the formation of this novel highly tetrahedral amorphous carbon having more than about 15% sp^3 carbon-carbon bonds and a single peak in the Raman spectrum. Hence, Applicants respectfully request that the rejection under 35 U.S.C. §102(e) with respect to the Taniguchi reference be removed.

With respect to the Cuomo et al. reference, Applicants respectfully note that this application was filed on October 11, 1996. The present application is a divisional of and claims

priority from application no. 08/761,336 filed December 10, 1996, now U.S. Patent No. 5,858,477, which claims priority from provisional application nos. 60/018,793 filed May 31, 1996 and 60/018,746 filed May 31, 1996. Applicants believe that all of the subject matter of present claims 38, 45, and 46 is fully supported under 35 U.S.C. §112 in priority application no. 60/018,793, filed on May 31, 1996. Specifically, support for the present claims 38, 45, and 46 may be found in this earlier filing on page 10, line 31 through page 11, line 27; page 27, lines 12-26; Figure 8. Hence, under M.P.E.P. §706.02, the Cuomo et al. reference does not appear to be prior art under §102(e), and as such, withdrawal of this rejection is respectfully requested.

Rejection of Claims under 35 U.S.C. §103

Claims 38-46 were rejected under 35 U.S.C. §103(a) as allegedly being unpatentable over U.S. Patent No. 5,616,179, issued to Baldwin et al. Such a rejection is traversed in part and overcome in part as follows.

The prior rejection of claims 38-46 is now moot. As noted above, independent claim 38 is now directed to an article having a layer of highly tetrahedral amorphous carbon having more than about 15% sp^3 carbon-carbon bonds and a single peak Raman spectrum. Such elements have not been shown in the Baldwin et al. reference. In fact, Applicants fail to see even a remote suggestion for a highly tetrahedral amorphous carbon having more than about 15% sp^3 carbon-carbon bonds, much less a layer that forms a single peak in the Raman spectrum.

Applicants also note that the present rejection does not establish *prima facie* obviousness under 35 U.S.C. §103. The Examiner bears the initial burden to establish and support *prima facie* obviousness. [See In re Rinehart, 531 F.2d 1048, 189 U.S.P.Q. 143 (CCPA 1976).] Under M.P.E.P. §2142, the Examiner must show that the prior art references teach or suggest all of the limitations of the claims. The Baldwin et al. reference discloses a process for depositing amorphous carbon hydrogenated films on a surface of a substrate using an end-Hall ion source wherein the average energy per deposited carbon atom is between 50 eV and 100 eV. [See col. 5, lines 14-24; col. 10, lines 30-33.] As such the Examiner simply concludes that,

> Baldwin et al. discloses a substrate and a layer deposited over the substrate which is deemed to encompass the present claims since it appears to be produced by a method which is equivalent to applicants method wherein the average energy per deposited carbon atom is between 50 eV and 100 eV which overlaps the range of 57-130 eV taught by the present specification.

[See Office Action of January 22, 2001, page 4.] Although the present application describes deposition conditions in which each carbon ion impacts the substrate with an energy between 57 and 130 eV, the specification further states that the preferred range of operation is between about

100 and 120 eV for each carbon atom. [See page 6, lines 22-23.] A higher ionic impact energy range from 100 to 120 eV is preferred as it promotes significant levels of sp^3 bonding through subplantation. [See page 6, lines 18-23; page 8, lines 32-35.] This preferred range is not disclosed or suggested in the Baldwin et al. reference.

Moreover, Applicants note that the impact energy of each carbon ion is only one of many important factors that contributes to the formation of this novel highly tetrahedral amorphous carbon having more than about 15% sp^3 carbon-carbon bonds and a single peak in the Raman spectrum. For example, the present application describes deposition conditions in which the stream of carbon ions will be primarily composed of ions having a uniform weight and an impact energy which is substantially uniform. [See page 6, lines 28-38.] This uniformity may be promoted through the filtering of the ion stream via a filtered cathodic arc, as shown in Figure 5, or an extraction grid, as shown in Figure 3A. *Id.* Thus, the present application's deposition process of ionic filtering creates an ion stream having uniform constituents to the substrate. In contrast, the Baldwin et al. process does not teach or even suggest ionic filtering. In fact, a closer examination of this reference reveals the presence of non-uniform deposition constituents in its film. Specifically, the Baldwin et al. patent states on col. 6, lines 31-47 that,

> It has been observed that the thickness of a-C:H [amorphous carbon hydrogenated] film built up on the substrate is approximately a factor of two greater than can be accounted for by the ion current to the substrate alone .... it is believed that the carbon being deposited over and above the carbon from the ion flux comes [from activated species]. Such activated species may be atoms or molecular fragments ($-CH_x$ radicals) or from neutral, activated hydrocarbon gaseous species from the end-Hall ion source.

Hence, one half of the film deposited in the Baldwin et al. process contains non-uniform constituents, i.e. non-ionic species. It should also be noted such non uniform deposition systems may also give rise to pinholes which in turn prevents the films of Baldwin et al. from being continuous as compared to the uniform deposition systems of the present application which promote the formation of continuous films.

With respect to the Ueda et al. (U.S. Patent No. 5,637,393) and Onodera (U.S. Patent No. 5,607,783) citations, Applicants fail to see any teaching or suggestion for a layer comprising a highly tetrahedral amorphous carbon having more than about 15% sp^3 carbon-carbon bonds and a single peak in the Raman spectrum. In fact, the Ueda et al. reference discloses a carbon film characterized by at least two strong D and G peaks observed at 1380 cm^{-1} and 1550 cm^{-1} in the Raman spectra. [See Figure 5; col. 11, lines 1-4.]

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In summary, Applicants have invented and claimed a novel highly tetrahedral amorphous carbon. No reference now of record in this case even remotely teaches or sufficiently suggest a tetrahedral amorphous carbon having more than about 15% sp^3 carbon-carbon bonds and a single peak in the Raman spectrum, as is presently claimed. As *prima facie* obviousness has not been established, Applicants respectfully request that the rejection under 35 U.S.C. § 103 be removed and that claim 38 (and the dependent claims 39-46) be allowed.

Added Claims

Applicants have added dependent claims 48-61 to more fully claim the present invention. Support for added claims 48-52 is found in Figure 8 and associated text on page 34, paragraph 4, for claims 53 and 54 is found on page 7, lines 14-17, for claims 55-58 on page 13, line 33 to page 14, line 8, and for claims 59-61 on page 6, lines 22-30. Support for independent claims 62 and 63 can be found with reference to Figure 8 and associated text on page 34, paragraph 4.

CONCLUSION

In view of the foregoing, Applicants believe all claims now pending in this Application are in condition for allowance. The issuance of a formal Notice of Allowance at an early date is respectfully requested.

Attached is a marked up version of the changes made to the specification, claims, and drawing(s) by the current amendment. The attached page is captioned "VERSION WITH MARKINGS TO SHOW CHANGES MADE".

If the Examiner believes a telephone conference would expedite prosecution of this application, please telephone the undersigned at 650-326-2400.

Respectfully submitted,

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VERSION WITH MARKINGS TO SHOW CHANGES MADE

IN THE SPECIFICATION:

Please delete the paragraph starting on page 34, line 36 ending on page 35, line 4 and insert the following paragraph:

-- The Raman spectra of the filtered cathodic arc disks were also measure, and the results are provided in Fig. 8. Generally, these results indicated that a film can be deposited using a cathodic arc source which includes a G-peak in the area of about 1518, and having a G width of approximately 175. The pseudo band gap of this film appears to be roughly 1.68 eV, while the refractive index is approximately 2.5. The complex portion of the optical index of refraction, K, appears to be approximately .08 for the film. As illustrated in Fig. 8, the Raman spectra 200 is dominated by a single peak 202 that may be characterized by a generally smooth curve 204. In some instances, the generally smooth curve 202 may exhibit a localized secondary perturbation 206 that is offset from the smooth curve 202.--

IN THE CLAIMS:

Please cancel claims 17-37 and 47.

38. (Amended) An article **[apparatus]** comprising:

a substrate; and

a layer disposed over the substrate, the layer comprising a highly tetrahedral amorphous carbon having more than about 15% sp^3 carbon-carbon bonds and a single peak Raman spectrum, the layer further comprising at least one of hydrogen and nitrogen.

39. (Amended) An a article **[apparatus]** as in claim 38, wherein the layer comprises between about 8 and 18 atomic percent hydrogen.

40. (Amended) An article **[apparatus]** as in claim 38, wherein the layer comprises between about 4 and 30 atomic percent nitrogen.

41. (Amended) An article **[apparatus]** as in claim 40 **[38]**, wherein electrical conductivity of the layer varies with the nitrogen percentage.

42. (Amended) An article **[apparatus]** as in claim 41, wherein the electrical conductivity of the layer varies by 5 orders of magnitude.

43. (Amended) An article **[apparatus]** as in claim 38, wherein the sp^3 carbon-carbon bonds are stable at about 700°C.

44. (Amended) An article **[apparatus]** as in claim 38, wherein the layer is smooth and continuous.

45. (Amended) An article **[apparatus]** as in claim 38, wherein the layer comprises more than about 35% sp^3 carbon-carbon bonds.

46. (Amended) An article **[apparatus]** as in claim 38, wherein the layer comprises more than about 70% sp^3 carbon-carbon bonds.

Please add new claims 48-63.

--48. (New) An article as in claim 38, wherein the single peak Raman spectrum has a maximum peak intensity at about 1518 cm^{-1}.

49. (New) An article as in claim 48, wherein the maximum peak intensity is associated with a G-peak .

50. (New) An article as in claim 38, wherein the single peak Raman spectrum has a width of about 175 cm^{-1}.

51. (New) An article as in claim 38, wherein the single peak Raman spectrum is characterized by a generally smooth curve.

52. (New) An article as in claim 51, further comprising at least one localized secondary perturbation offset from the generally smooth curve.

53. (New) An article as in claim 38, wherein the layer has a thickness of less than about 75Å.

54. (New) An article as in claim 38, wherein the layer has a thickness of less than about 50Å.

55. (New) An article as in claim 38, wherein the layer has a hardness of over about 50 GPa.

56. (New) An article as in claim 38, wherein the layer has a hardness of about 80 GPa.

57. (New) An article as in claim 38, wherein the layer has a density of more than about 2.5 g/cm^3.

58. (New) An article as in claim 38, wherein the layer does not include macroparticles.

59. (New) An article as in claim 38, wherein the sp^3 carbon-carbon bonds are at least in part formed by directing an energized stream of carbon ions having a uniform weight toward the substrate.

60. (New) An article as in claim 38, wherein the sp^3 carbon-carbon bonds are at least in part formed by directing an energized stream of carbon ions having a substantially uniform impact energy toward the substrate.

61. (New) An article as in claim 38, wherein the sp^3 carbon-carbon bonds are at least in part formed by directing an energized stream of carbon ions toward the substrate with an ion impact energy between about 100 and 120 eV for each carbon atom.

62. (New) An article comprising:

a substrate; and

a layer disposed over the substrate, the layer comprising a highly tetrahedral amorphous carbon having more than about 15% sp^3 carbon-carbon bonds and a carbon bonding pattern characterized by a single peak Raman spectrum.

63. (New) An article comprising:

a substrate; and

a layer disposed over the substrate, the layer comprising a highly tetrahedral amorphous carbon having more than about 15% sp^3 carbon-carbon bonds and a carbon bonding pattern being free from a D-peak Raman spectrum.--

IN THE DRAWINGS:

In Fig. 8, please insert the following reference numerals, as shown in red ink on an enclosed copy of the submitted drawing:

--200--, --202--, --204--, and --206--.